

**Coho and Chinook Salmon Smolt Releases into Cook
Inlet, Prince William Sound, and Resurrection Bay,
Alaska, 2009**

by

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and

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September 2015

Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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Weights and measures (metric)		General		Mathematics, statistics	
centimeter	cm	Alaska Administrative Code		all standard mathematical signs, symbols and abbreviations	
deciliter	dL		AAC		
gram	g	all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.	alternate hypothesis	H _A
hectare	ha			base of natural logarithm	<i>e</i>
kilogram	kg	all commonly accepted		catch per unit effort	CPUE
kilometer	km	professional titles	e.g., Dr., Ph.D., R.N., etc.	coefficient of variation	CV
liter	L			common test statistics	(F, t, χ^2 , etc.)
meter	m	at	@	confidence interval	CI
milliliter	mL	compass directions:		correlation coefficient (multiple)	R
millimeter	mm	east	E	correlation coefficient (simple)	r
Weights and measures (English)		north	N	covariance	cov
cubic feet per second	ft ³ /s	south	S	degree (angular)	°
foot	ft	west	W	degrees of freedom	df
gallon	gal	copyright	©	expected value	<i>E</i>
inch	in	corporate suffixes:		greater than	>
mile	mi	Company	Co.	greater than or equal to	≥
nautical mile	nmi	Corporation	Corp.	harvest per unit effort	HPUE
ounce	oz	Incorporated	Inc.	less than	<
pound	lb	Limited	Ltd.	less than or equal to	≤
quart	qt	District of Columbia	D.C.	logarithm (natural)	ln
yard	yd	et alii (and others)	et al.	logarithm (base 10)	log
		et cetera (and so forth)	etc.	logarithm (specify base)	log ₂ , etc.
Time and temperature		exempli gratia		minute (angular)	'
day	d	(for example)	e.g.	not significant	NS
degrees Celsius	°C	Federal Information Code	FIC	null hypothesis	H ₀
degrees Fahrenheit	°F	id est (that is)	i.e.	percent	%
degrees kelvin	K	latitude or longitude	lat or long	probability	P
hour	h	monetary symbols		probability of a type I error	
minute	min	(U.S.)	\$, ¢	(rejection of the null hypothesis when true)	α
second	s	months (tables and figures): first three		probability of a type II error	
Physics and chemistry		letters	Jan,...,Dec	(acceptance of the null hypothesis when false)	β
all atomic symbols		registered trademark	®	second (angular)	"
alternating current	AC	trademark	™	standard deviation	SD
ampere	A	United States		standard error	SE
calorie	cal	(adjective)	U.S.	variance	
direct current	DC	United States of America (noun)	USA	population sample	Var var
hertz	Hz	U.S.C.	United States Code		
horsepower	hp				
hydrogen ion activity (negative log of)	pH	U.S. state	use two-letter abbreviations (e.g., AK, WA)		
parts per million	ppm				
parts per thousand	ppt, ‰				
volts	V				
watts	W				

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**COHO AND CHINOOK SALMON SMOLT RELEASES INTO COOK
INLET, PRINCE WILLIAM SOUND, AND RESURRECTION BAY,
ALASKA, 2009**

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ABSTRACT

In 2009, the Alaska Department of Fish and Game released approximately 834,233 coho salmon (*Oncorhynchus kisutch*) smolt and 1,061,516 Chinook salmon (*O. tshawytscha*) smolt in Cook Inlet, Prince William Sound, and Resurrection Bay to increase angling opportunity and relieve angling pressure on wild stock salmon populations. There were 10 Chinook salmon and 7 coho salmon release groups in all. Every smolt in each release group was thermally marked to later identify the release area of returning adults. Chinook salmon smolt from 3 groups released at brood collection sites (281,154 thermally marked fish) were also marked with an adipose fin clip and a coded wire tag to identify hatchery fish (adipose fin missing) from naturally produced fish (adipose fin present) in the fishery, brood collections, and escapements at those sites. For individual release groups, the percentage of fish retaining coded wire tags and with acceptable fin clips ranged from 99.1% to 100.0% and 99.7% to 100%, respectively. Fish size distribution at time of release was estimated for 2 coded-wire-tagged Chinook salmon release groups and 1 coho salmon release group without coded wire tags. Both of the coded-wire-tagged Chinook salmon release groups achieved a smolt production goal of 80% within a target size range of 5.1–15.0 g. Although the coho salmon smolt production goal was to have 80% of the release group within a target size range of 15.1–25.0 g, only 4.2% fell within the target size range. Smolt were enumerated in the 3 coded-wire-tagged Chinook salmon release groups. Hatchery inventory methods were used to estimate the number of smolt in 6 coho salmon release groups and in 3 other Chinook salmon release groups. Water volume inventory methods were used to estimate the number of coho and Chinook salmon smolt in the remaining release groups (1 and 4 release groups, respectively).

Key words: hatchery, adipose finclip, coded wire tags, thermal marking, otolith, Chinook salmon, *Oncorhynchus tshawytscha*, coho salmon, *Oncorhynchus kisutch*, tag retention, size composition.

INTRODUCTION

Southcentral Alaska receives most of the state's sport fishing effort. Chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) smolt reared at Alaska Department of Fish and Game (ADF&G) Division of Sport Fish (SF) hatcheries have been released in numerous locations throughout Southcentral Alaska to improve or create terminal sport fisheries and relieve pressure on wild stocks (Appendices A1 and A2). One element of the coho and Chinook salmon hatchery smolt stocking projects in Cook Inlet, Prince William Sound, and Resurrection Bay is the use of thermal marks (TM) to identify fish. All fish raised at Fort Richardson Hatchery (FRH) are thermal marked. In 2009, 100% of 3 release groups of salmon smolt were also marked with an adipose fin clip and a coded wire tag (CWT). TMs and CWTs are used to estimate the contribution of hatchery releases to commercial fisheries, marine and freshwater recreational fisheries, and personal use fisheries. They can also be used to estimate spawning escapement in stocked streams, and estimate straying of stocked coho and Chinook salmon.

The accuracy of hatchery contribution estimates is highly dependent upon the accuracy of the estimated number of fish released. To ensure the greatest accuracy in determining the number of fish in release groups, 3 methods are used at FRH: a tagging inventory (TI) count, a hatchery inventory (HI) estimate, and a water volume displacement (WV) estimate. These are compared and the best estimate is used.

Another important element of hatchery smolt stocking programs is fish size. Weight and length of smolt at release are indicators of quality (Peltz and Starkey 1993). If smolt are too small at release, then ocean survival will be poor; and if smolt are too large at release, then ocean residence will be reduced, thus shifting age composition of returns to younger, smaller fish (Sweet and Peltz 1994). To maximize ocean survival of hatchery smolt and achieve an age composition similar to the age composition of the existing population, Peltz and Starkey (1993) recommend that upon release, 80% of hatchery coho salmon smolt weigh between 15.1 and 25.0 g, and 80% of hatchery Chinook salmon weigh between 5.1 and 15.0 g.

This project documented the release of Chinook and coho salmon smolts with TMs and CWTs in Cook Inlet, Prince William Sound, and Resurrection Bay in 2009. Specific objectives for this project were as follows:

1. Estimate the long-term (greater than 30 days) tag retention rate and adipose-clip quality of each smolt release group with CWTs.
2. Verify the TM applied to the otoliths of fish in each coho and Chinook salmon release group.
3. Estimate the weight distribution of each Chinook salmon smolt release group with CWTs and 1 coho salmon smolt release group without CWTs.

Our tagging goal was to mark all Chinook salmon smolt in 3 release groups with an adipose fin clip and a CWT. A second goal was to mark all fish in all release groups with a thermal mark. We also compared smolt abundance by applying hatchery inventory (HI) and water volume displacement (WV) estimates to the tagging inventory (TI) count for all Chinook salmon release groups marked with an adipose fin clip and CWT.

Included in this report are recommendations for future marking and collecting of smolt release data. All data for this report are held and archived by Research and Technical Services, Division of Sport Fish, Alaska Department of Fish and Game.

METHODS

Coho salmon smolt from Bear Lake, Ship Creek (Little Susitna River), and Jim Creek donor stocks were raised at Fort Richardson Hatchery (FRH). Chinook salmon smolt from Deception Creek, Ship Creek, Crooked Creek, and Ninilchik River donor stocks were also raised at FRH (Table 1). Fish from 17 release groups were released at 10 locations in Cook Inlet, 2 locations in Prince William Sound, and 2 locations in Resurrection Bay.

Table 1.—Total number of fish stocked at 14 locations in Cook Inlet, Prince William Sound, and Resurrection Bay in 2009.

Species	Release area ^a	Release location	Donor stock	Inventory method	Estimated number in release group
Chinook salmon					
	CI	Deception Creek	Deception Creek	tagging	111,322
	CI	Ship Creek	Ship Creek	hatchery	282,735 ^b
	CI	Eklutna Tailrace	Ship Creek	water volume	77,785 ^b
	CI	Crooked Creek	Crooked Creek	tagging	115,035 ^b
	CI	Halibut Cove	Ninilchik River	water volume	35,065 ^b
	CI	Homer Spit	Ninilchik River	water volume	164,234 ^b
	CI	Seldovia	Ninilchik River	water volume	44,487 ^b
	CI	Ninilchik River	Ninilchik River	tagging	54,797
	PWS	Fleming Spit	Deception Creek	hatchery	68,173 ^b
	PWS	Valdez, Old Town Site	Deception Creek	hatchery	107,883 ^b

-continued-

Table 1.–Part 2 of 2.

Species	Release area ^a	Release location	Donor stock	Inventory method	Estimated number in release group
Coho salmon					
	CI	Bird Creek	Ship Cr (Little Susitna River)	hatchery	113,300
	CI	Campbell Creek	Ship Cr (Little Susitna River)	hatchery	15,400
	CI	Eklutna Tailrace	Eklutna Tailrace (Jim Creek)	hatchery	120,200
	CI	Homer Spit	Ship Cr (Little Susitna River)	hatchery	113,696 ^b
	CI	Ship Creek	Ship Cr (Little Susitna River)	hatchery	287,825 ^b
	RB	Lowell Creek	Bear Lake	hatchery	91,833
	RB	Seward Lagoon	Bear Lake	hatchery	91,979
Total					1,895,749

^a CI is Cook Inlet; PWS is Prince William Sound; RB is Resurrection Bay.

^b Estimated release number adjusted for mortalities that occurred at release sites during imprinting.

SMOLT MARKING

Coded Wire Tagging

All Chinook salmon smolt in 3 release groups were adipose finclipped and injected with a coded wire tag (CWT; Table 2). Unique tag codes were used for each release group marked with CWTs.

A head mold was used to hold fish in the correct position and orientation for tagging. To determine which head mold sizes would provide the best tag placement, approximately 100 fish from each of the 3 release groups were measured from tip of snout to tail fork (to the nearest millimeter) within 7 days of tagging. Two or 3 head mold sizes that fit at least 80% of the length distribution were selected for tagging (Peltz and Hansen 1994). All fish were graded and tagged accordingly with a full-length CWT (1.1 mm) using a Northwest Marine Technology¹ Mark IV tag injector.

Fish were anesthetized with Tricaine Methane Sulfonate (MS-222) before tagging. The adipose fin was excised at the base using surgical scissors. Tags were then injected into the noses of the fish, and the fish were sent through a Quality Control Device (QCD). The QCD detected the magnetized tag and separated the fish with tags from those without tags. All fish without tags were injected again. Quality control checks for tag placement were conducted following initial daily startup, and following a change in head mold size or a change in tagging personnel. During each quality control check, a minimum of 2 tagged fish were dissected to determine tag placement (Moberly et al. 1977; Figure 1). Head mold or wire placement adjustments were made when necessary. The fish that were dissected to determine tag placement were not included in the tagged fish counts.

¹ Product names used in this publication are included for completeness but do not constitute product endorsement.

Table 2.—Summary of coded-wire-tagging data and smolt release estimates for Chinook salmon stocked in Cook Inlet, 2009.

Release parameter	Chinook salmon release site			Totals
	Deception Creek ^a	Ninilchik River	Crooked Creek	
Fish with adipose finclip and CWT				
Initial number	115,287	55,085	118,153	288,525
Mortalities	3,965	288	3,118	7,371
Total released (tagging inventory)	111,322	54,797	115,035	281,154
Coded Wire Tags				
Tag codes	31-03-77	31-03-76	31-03-75	
	31-03-50		31-03-74	
	31-03-49		31-03-14	
Tagging dates	11/7/2008	12/1/2008	10/21/2008	
	11/26/2008	12/8/2008	11/6/2008	
Date of tag retention check	ND	5/13/2009	5/29/2009	
Days elapsed	ND	187	204	
Tag retention sample size	ND	805	764	
Estimated tag retention at release	100%	99.1%	99.2%	
Tag retention variance	ND	1.07214E-05	1.0212E-05	
Estimated number released with tags	111,322	54,304	114,115	279,741
Tagged fish variance	ND	32,193	134,429	
Adipose finclips				
Percentage of fish with acceptable clips ^b	99.8%	100.0%	99.7%	
Estimated number released with clips	111,099	54,797	114,734	280,630

^a Deception Creek release group was released without being checked for long-term tag retention or acceptable adipose finclip rates.

^b An acceptable rating was given to fish with at least 80% of the adipose fin removed.

After tagging, all fish were held overnight in net pens to determine short-term mortality and short-term tag retention rates. All overnight mortalities were counted and recorded. Short-term retention rates were estimated daily by passing a random sample of 200 fish through the QCD. Daily tag retention rate (D_i) of surviving smolt was estimated as a binomial proportion:

$$\hat{D}_i = \frac{n_i}{n_{ti}} \quad (1)$$

where

n_i = number of live smolt in the sample tagged on day i that retained the tag, and

n_{ti} = total number of live smolt in the sample tagged on day i ,

and a variance of

$$Var(\hat{D}_i) = \frac{\hat{D}_i(1 - \hat{D}_i)}{n_{ti} - 1}. \quad (2)$$

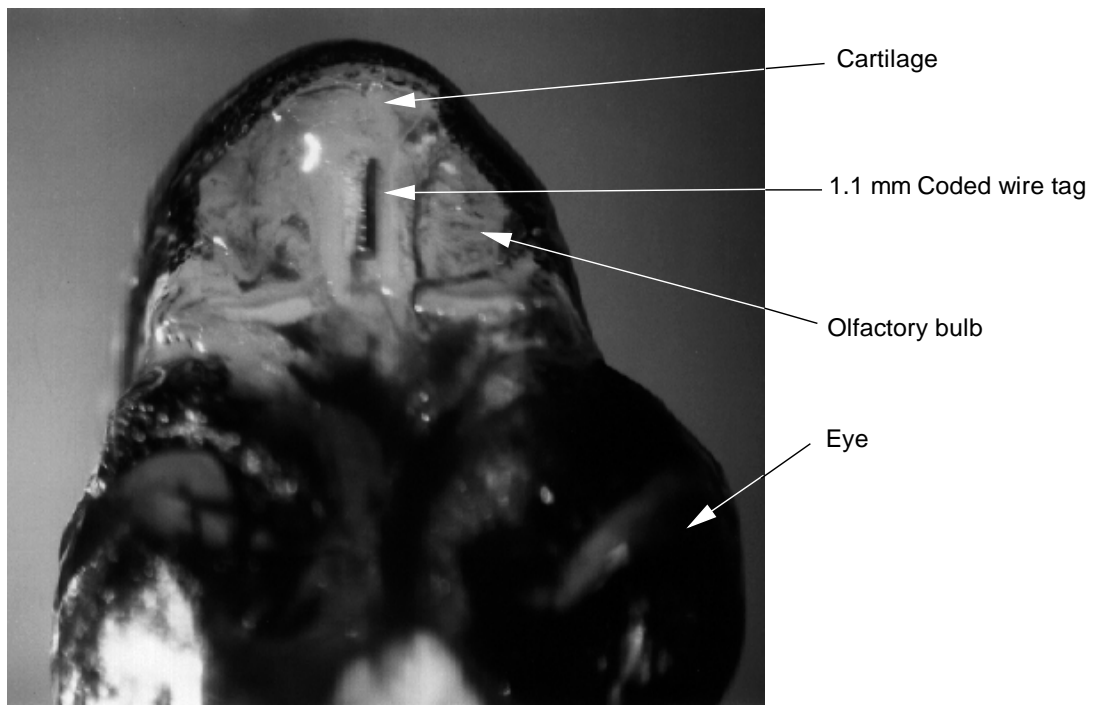
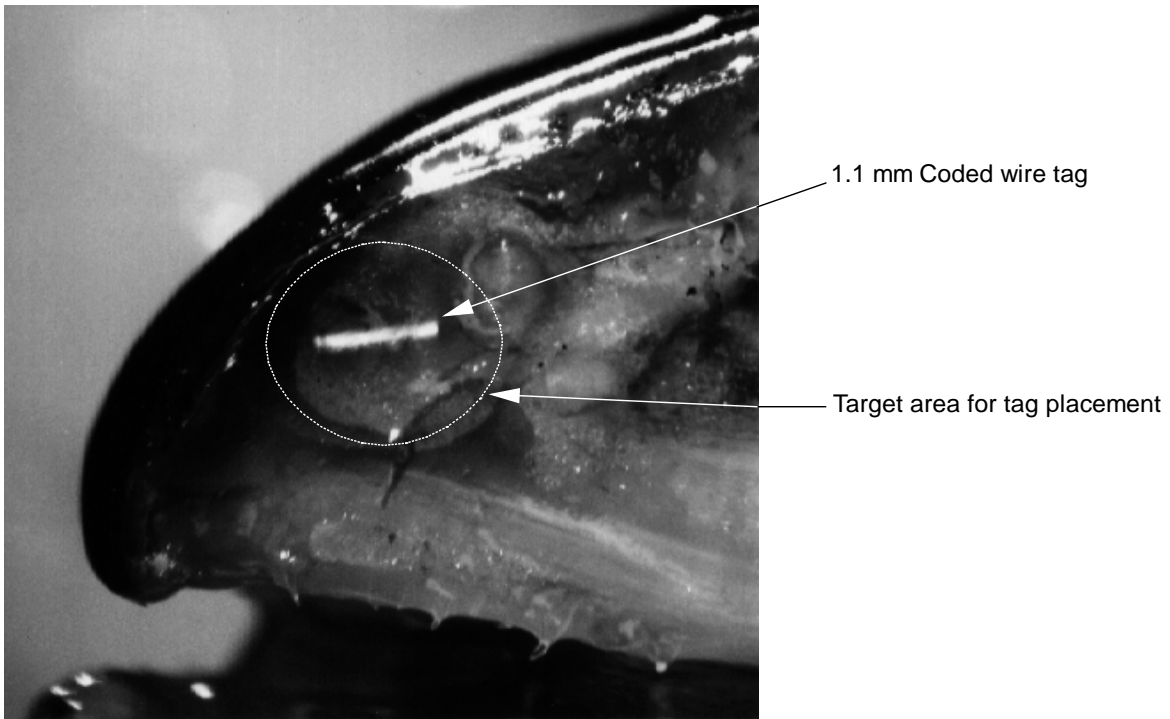


Figure 1.—Proper placement of a coded wire tag in a small fish.

Fish checked for overnight tag retention were also examined for adipose-finclip quality. At least 80% fin removal, as visually estimated by the technician performing the quality control check, was required for the clip to be acceptable.

Tagged smolt were transferred to the rearing unit following overnight mortality checks and held until release. Fish mortality was monitored daily and all mortalities were recorded.

Long-term tag retention was estimated for all release groups at least 30 days after tagging (Blankenship 1990). At least 750 finclipped fish were randomly sampled from the population and checked for tag retention using a hand-held CWT detector. The long-term tag retention rate (D_j) of surviving smolt and its variance were also estimated as binomial proportions (Equations 1 and 2) for each group where

n_i = number of smolt in the sample that retained the tag, and

n_{ti} = total number of tagged smolt in the sample.

The number of fish released with CWTs was estimated as follows:

$$\hat{T}_j = (N_j - M_j)\hat{D}_j \quad (3)$$

and its variance

$$Var(\hat{T}_j) = (N_j - M_j)^2 Var(\hat{D}_j) \quad (4)$$

where

N_j = number of fish injected with a tag in group j ,

\hat{D}_j = long-term tag retention of release group j , and

M_j = total number of mortalities of tagged fish in group j .

A minimum of 750 smolt per rearing unit were examined for adipose-finclip quality within 7 days of release. Fin clips were rated as acceptable or not acceptable. An acceptable rating was given to those determined by visual estimation with at least 80% of the adipose fin removed.

Thermal Marks (TMs)

Thermal marks were applied to all coho and Chinook salmon embryos before hatching. Thermal mark patterns were assigned by the Mark, Tag, and Age Laboratory operated by ADF&G Division of Commercial Fisheries (Table 3). At approximately 310 cumulative temperature units (CTUs)—number of days postfertilization multiplied by average daily temperature in centigrade—for coho salmon and 360 CTUs for Chinook salmon, otoliths were developed enough to accept a mark, as verified by the Mark, Tag, and Age Laboratory. Embryos were exposed to a series of 4–5°C water temperature changes (both increases and decreases), with each temperature decrease resulting in the deposit of a dark protein ring on the developing otolith (Monk *Unpublished*). Water temperature changes were scheduled every 24 hours, with a 72-hour warm water exposure occurring between bands of rings. The assigned patterns of dark protein rings applied to the otoliths (Figure 2) are used to identify the area of release from returning adult salmon. Onset Stowaway XTI data loggers recorded incubation water temperature every 15

minutes throughout the marking period to generate thermal profiles for each mark type (Figure 3).

Voucher samples containing approximately 50 fish from each egg lot were collected before moving fish to the raceways (ponding) and submitted to the Mark, Tag, and Age Laboratory for mark verification.

Table 3.—Summary of Chinook and coho salmon thermal marks (hatch codes) for smolt stocked at locations in Cook Inlet, Prince William Sound, and Resurrection Bay in 2009.

Species	Release area	Release location	Intended hatch code ^a	Variant hatch codes ^b
Chinook salmon				
	Cook Inlet	Ship Creek	2,3H	2,4H; 2,2,3H; or 2,4,2H
	Cook Inlet	Eklutna Tailrace	2,3H	2,4H; 2,2,3H; or 2,4,2H
	Cook Inlet	Ninilchik River	2,3H	2,4H; 2,2,3H; or 2,4,2H
	Cook Inlet	Halibut Cove	2,3H	2,4H; 2,2,3H; or 2,4,2H
	Cook Inlet	Seldovia	2,3H	2,4H; 2,2,3H; or 2,4,2H
	Cook Inlet	Homer Spit	2,3H	2,4H; 2,2,3H; or 2,4,2H
	Cook Inlet	Deception Creek	2,3H	2,4H; 2,2,3H; or 2,4,2H
	Cook Inlet	Crooked Creek	2,3H	2,4H; 2,2,3H; or 2,4,2H
	Prince William Sound	Fleming Spit	2,4H	none
	Prince William Sound	Valdez	2,4H	none
Coho salmon				
	Cook Inlet	Ship Creek	1,5H	7H
	Cook Inlet	Campbell Creek	1,5H	7H
	Cook Inlet	Bird Creek	1,5H	7H
	Cook Inlet	Homer Spit	1,5H	7H
	Cook Inlet	Eklutna Tailrace	1,5H	7H
	Resurrection Bay	Lowell Creek	2,4H	3,4H
	Resurrection Bay	Seward Lagoon	2,4H	3,4H

^a Hatch codes indicate the number of rings.

^b Variant hatch codes observed during voucher sample thermal mark verification.

Coho Salmon

Coho salmon were thermally marked in 2007 at the eyed egg stage of development (Table 3). Different TMs consisting of 2 bands were applied to identify the fish as belonging to Cook Inlet or Resurrection Bay release groups. Cook Inlet release groups were indicated by 1 band of 1 ring followed by 1 band of 5 rings (1,5H), and Resurrection Bay release groups were indicated by 1 band of 2 rings followed by 1 band of 4 rings (2,4H).

Chinook Salmon

Chinook salmon were thermally marked in 2007 at the eyed egg stage of development (Table 3). Different TMs consisting of 2 bands were applied to identify the fish as belonging to a Cook Inlet or Prince William Sound release group. The first band consisted of 2 rings for all fish, and the second band consisted of 3 rings for Cook Inlet release groups (2,3H) or 4 rings for Prince William Sound release groups (2,4H).

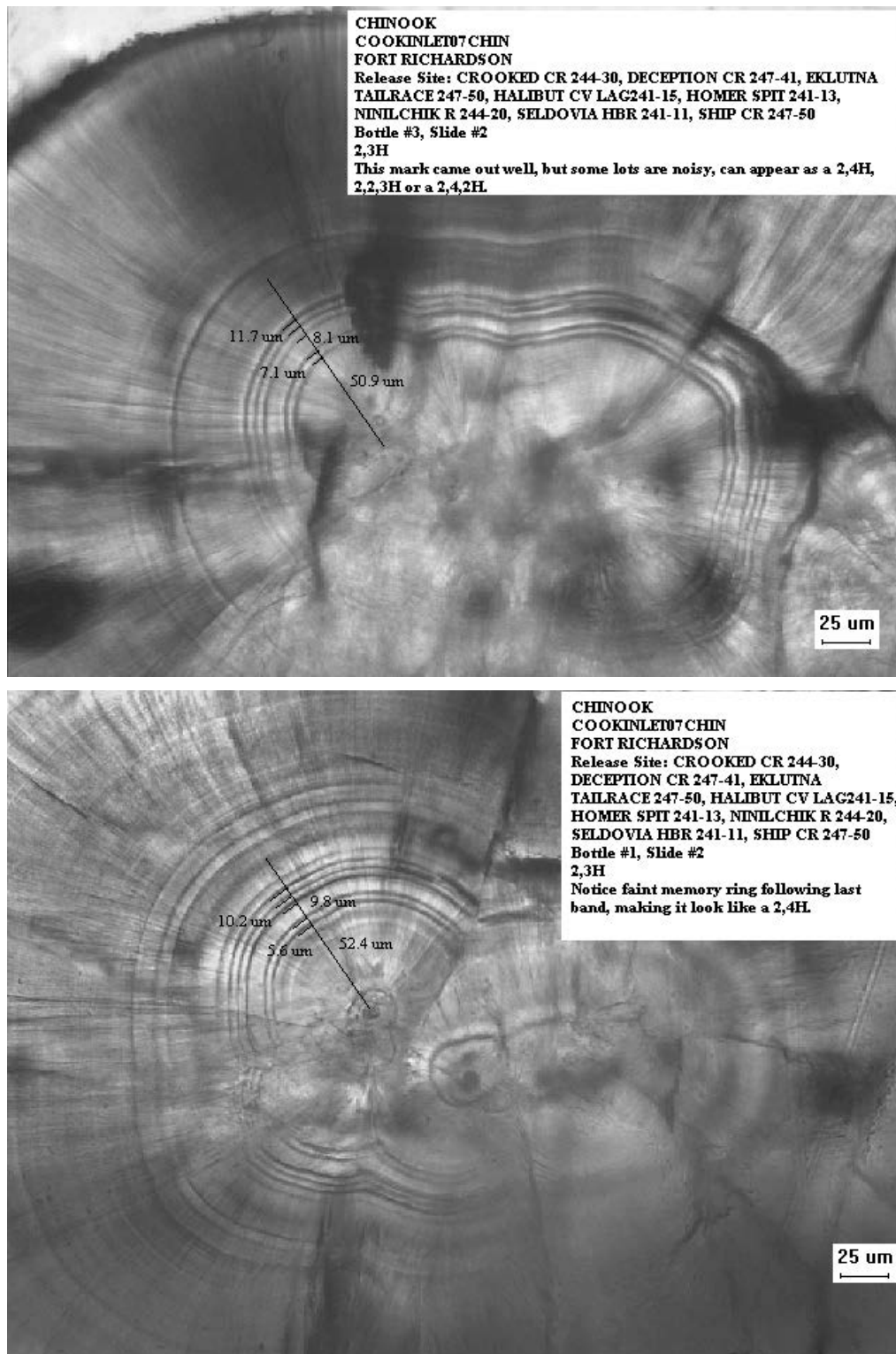


Figure 2.—Images of a thermal mark applied to Chinook salmon released into Cook Inlet.

Note: The top image shows the intended thermal mark hatch code 2,3H. The bottom image shows a variant of the intended thermal mark hatch code.

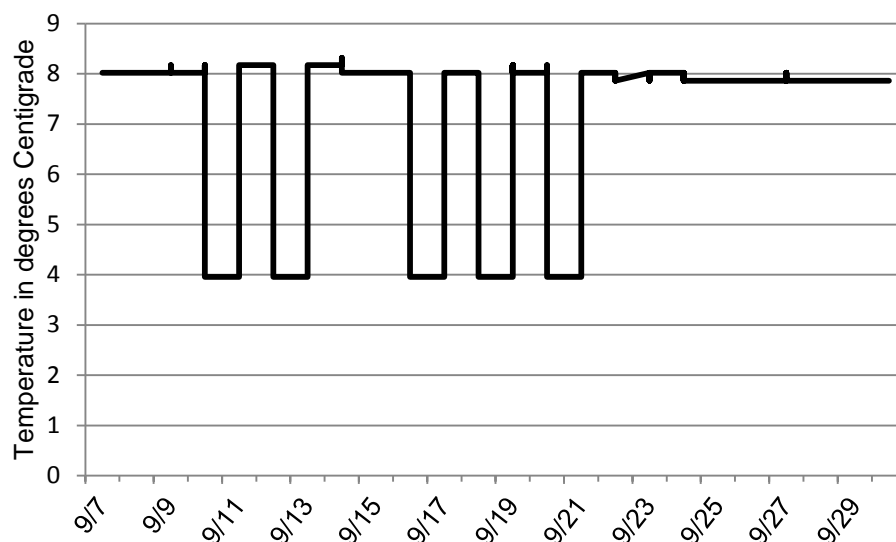


Figure 3.—Thermal marking temperature profile for Chinook salmon released into Cook Inlet in 2009 with a thermal mark (hatch code) of 2,3H.

SMOLT ENUMERATION

The number of fish in all 17 release groups was obtained (before release) using either the tagging inventory (TI) count, hatchery inventory (HI) abundance estimate, water volume displacement (WV) abundance estimate, or a combination thereof (see below for details on each of these methods). The TI counts were compared to the HI and WV estimates to determine the precision of the HI and WV estimates. In raceways where a TI was not conducted, and the HI and WV point estimates differed by less than 10%, the HI estimates were used. If the point estimates differed by more than 10% from the TI count, then the estimates were reviewed.

Tagging Inventory (TI)

A TI count was obtained from the tag counter on the Mark IV CWT injector for the 3 Chinook salmon release groups in which every fish was injected with a CWT. Thus, the number of injected tags counted for each release group equaled the number of fish in each release group. For these release groups, fish mortality was monitored daily and subtracted from the original TI count to yield a final fish count for each release group.

Hatchery Inventory (HI) Estimates

The HI abundance technique used at Fort Richardson (FRH) was based on the weight of fish in a raceway. These estimates were obtained when fingerlings were moved from small indoor raceways to large outdoor raceways. Three randomly selected net loads of fish—1 each from the head, middle, and tail sections of the raceway—were used to estimate mean fish weight. If the fish were congregated at one end of the raceway, the samples were obtained from the congregation of fish. If a sample varied by more than 5% from the other samples, another sample was obtained. Because a net load of fish is too large to enumerate (approximately 600–800 fish), the net was manually halved numerous times until a visually estimated 50–100 fish remained in the net. Each net of fish was then held out of the water for several seconds to allow water to drain from the net. The fish were then poured into a preweighed bucket of water, weighed to the

nearest gram, and hand counted from the bucket to determine mean fish weight. Mean weight was estimated for each sample by dividing the total weight of the fish counted by the number of fish counted. The total weight of fish, obtained using the accumulative weight feature on the electronic scale, was then divided by the mean fish weight to establish the HI abundance estimate in that raceway. The number of fish released from an outdoor raceway equaled the original outdoor raceway estimate minus the fish stocked or transferred and minus the mortalities from date of loading into the outdoor raceway to the date of release.

Volumetric (WV) Estimates

Fish abundance (number or weight) was also estimated volumetrically using the known size of transport tank used to transport fish to the release site. This estimate is a function of the tank volume (gallons), the ratio of the volume of water displaced in the tank sight gauge to the volume of water placed in the tank (mm/gallon), and the ratio of the number (or weight) of fish which displace a volume of water in the tank sight gauge (fish/mm or kg/mm).

For fish transport, each tank was filled with water and the water level on the tank sight gauge recorded to the nearest millimeter. Fish were then pumped from the raceway into each of the transport tanks. The water level on the tank gauge was recorded again after fish were loaded into each of the tanks. The millimeters of water displaced for each tank was determined, and using a known displacement value of kilograms of fish per millimeter (Appendix B1), the total weight of fish in the tank was estimated. Total number of fish was estimated by dividing the total fish weight by the mean fish weight.

FRH estimated mean weight by obtaining fish samples from 5 nets of fish before loading the tanks. Each net of fish was split in half several times until the desired sample size (50–100 fish) was achieved. The fish were poured into a preweighed bucket of water, weighed to the nearest gram, and counted out of the bucket. Mean weight was calculated for each of the 5 samples, and an overall mean weight was calculated by summing the 5 sample mean weights and dividing by the sum of the 5 fish counts.

SIZE ESTIMATION

A sample of fish from 2 raceways containing CWT-tagged Chinook salmon and 1 raceway of coho salmon were individually weighed and measured. Fish were crowded to one end of the raceway and a minimum of 510 fish were dipnetted and put into a small holding pen. Each fish sampled was measured to the nearest millimeter and weighed to the nearest 0.1 g.

RESULTS

SMOLT MARKING

Coded Wire Tags (CWTs)

Based on tagging inventory counts, 281,154 Chinook salmon smolt with an adipose finclip and CWT were released in Cook Inlet in 2009 (Table 2). The goal of 100% of the Chinook salmon CWT-tagged in 3 release groups was achieved.

Long-term tag retention was estimated 187–204 days post-tagging (Table 2). Tag retention rates ranged from 99.1% to 99.2% (Table 2). Adipose fin clip quality ranged from 99.7% to 100%. Deception Creek smolt were not sampled because the fish were released before their scheduled

sampling and release dates. Overnight tag retention and adipose finclip quality are not reported for the Deception Creek release group.

Thermal Marks (TMs)

Thermal profiles recorded by the Onset Stowaway XTI data loggers indicated that temperature changes for all Chinook and coho salmon release groups occurred as scheduled. However, TM digital images of voucher samples indicated that variants from the planned TM exist for 3 of the 4 TMs applied (Table 3). The TM variant for the Cook Inlet coho salmon appears as 7H instead of 1,5H. The TM variant for the Resurrection Bay coho salmon appears as 3,4H instead of 2,4H. The TM variants for the Cook Inlet Chinook salmon appear as 2,4H; 2,2,3H; or 2,4,2H instead of 2,3H. No TM variants were found for the Prince William Sound Chinook Salmon.

SMOLT RELEASES

In 2009, Fort Richardson Hatchery (FRH) released an estimated 834,233 coho salmon smolt at 7 locations in Cook Inlet and Resurrection Bay and an estimated 1,061,516 Chinook salmon smolt at 10 locations in Cook Inlet and Prince William Sound (Table 1).

SMOLT ENUMERATION

Tagging inventory (TI) counts were reported and compared to the results of hatchery inventory (HI) and water volume displacement (WV) estimates for the 3 TI Chinook salmon release groups. For the Deception Creek and Crooked Creek releases, the TI counts were within 6.3% of the HI estimates and within 7.5% of the WV estimates (Table 4). The TI count obtained while tagging the Ninilchik River release group was approximately 18,119 fish fewer (33.3% percent difference) than the HI estimate. An additional 18,865 fish were transferred and tagged into the Ninilchik River release group to bring the TI count to 54,797 fish at the completion of tagging. The TI count and WV estimate for the Ninilchik River release group differed by 54.3% at release.

HI estimates and WV estimates for 3 Chinook salmon releases (Homer Spit, Halibut Cove, and Seldovia) reared in D-Bank raceways (D2 head, D3 head, and D3 tail respectively) differed by more than 56% at release. For these release groups, the WV estimate was less than the HI estimate or the TI count. The Ninilchik River release group was also reared in a D-Bank raceway (Table 4).

The difference in HI estimates and WV estimates for all 4 B-Bank raceways ranged from 11.9% to 19.5%. The TI count for 2 C-Bank (C2 and C3) raceways and the HI estimate for 2 C-Bank (C1 and C4) raceways were within 7.5% of the WV displacement estimate (Table 4).

The difference in HI and WV estimates for coho salmon releases varied from 2.8% to 10.3%. The HI estimates were reported as the release number for all 7 coho salmon release groups and 3 of the 10 Chinook salmon release groups. WV estimates were reported for 4 Chinook salmon release groups.

Table 4.—A comparison of hatchery inventory (HI) estimates, water volume displacement (WV) population estimates, and tagging inventory (TI) counts (where available) for Chinook and coho salmon reared at Fort Richardson Hatchery and released in 2009.

Release species and site	Rearing unit	Smolt abundance estimate			TI/HI difference ^a	TI/WV difference ^b	HI/WV difference ^c	mortality ^d	Reported release number
		HI	WV	TI					
Chinook salmon									
Crooked Creek ^a	C2	121,460	107,506	115,603	4.8%	-7.5%	-13.0%	568	115,035
Deception Creek	C3	104,723	104,800	111,322	-6.3%	-6.2%	0.1%		111,322
Ninilchik River at tagging ^{a, b}	D2B	54,482	-	36,363	33.3%				
Ninilchik River at release ^{a, c}	D2B		35,512	54,797	N/A	-54.3%			54,797
Eklutna Tailrace	B4	94,169	78,800				-19.5%	1,015	77,785
Fleming Spit ^a	C4	109,643	103,413				-6.0%	41,470	68,173
Halibut Cove ^a	D3A	88,569	35,875				-146.9%	810	35,065
Homer Spit ^a	D1	113,172	109,021				-3.8%	1,105	107,916
Homer Spit ^a	D2A	113,700	57,087				-99.2%	769	56,318
Seldovia ^a	D3B	70,356	44,979				-56.4%	492	44,487
Ship Creek ^a	B1	98,104	87,556				-12.0%	4,026	94,078
Ship Creek ^a	B2	102,135	89,695				-13.9%	4,192	97,943
Ship Creek ^a	B3	94,596	84,500				-11.9%	3,882	90,714
Valdez ^a	C1	109,262	108,640				-0.6%	1,379	107,883
Coho salmon									
Bird Creek	F3	113,300	107,477				-5.4%		113,300
Campbell Cr	F4	ND	15,400						15,400
Eklutna Tailrace	F2	120,200	128,748				6.6%		120,200
Homer Spit ^a	F1	113,907	109,760				-3.8%	211	113,696
Lowell Creek	E2	91,833	-						91,833
Seward Lagoon	E1	91,979	89,676				-2.6%		91,979
Ship Creek ^a	E3	113,807	117,333				3.0%	416	113,391
Ship Creek ^a	E4	112,805	109,760				-2.8%	412	112,393
Ship Creek ^a	F4	62,268	56,449				-10.3%	227	62,041

Note: For rearing units that did not contain tagged fish, neither a tagging inventory nor comparisons to a tagging inventory could be obtained.

^a Estimates include mortalities that occurred at the release site while holding fish for imprinting. These estimates differ from the final release number presented in Table 1.

^b Tagging inventory is the initial number of tagged fish in the rearing unit. Hatchery inventory is the inventory at the time of tagging. Displacement inventory is not determined at tagging.

^c Displacement estimate obtained at release. Tagging inventory is the number of surviving tagged fish at release. This includes the additional 18,865 fish transferred from rearing unit D3B during tagging to make up for the shortfall in the Ninilchik River release group.

^d Includes transfer, post-transfer, and holding mortality.

SIZE ESTIMATION

The production goal for coho salmon was to have 80% of the fish weigh between 15.1 and 25.0 g. The 1 coho salmon release group (Homer Spit) sampled for weight did not achieve the production goal (4.2%, Table 5). The production goal for Chinook salmon was to have 80% of the fish weigh between 5.1 and 15.0 g. Both Chinook salmon release groups sampled achieved the production goal (Crooked Creek = 96.9%, Ninilchik River = 97.7%) (Table 5). The Deception Creek release group was not sampled prior to release.

Table 5.—The percentage of Chinook salmon in CWT release groups and in a single coho salmon release group from Fort Richardson Hatchery in 2009 that are within, smaller than, and larger than the production goal target size ranges.

Species	Release group	Percent		
		Below target	Within target	Above target
Coho salmon ^a	Homer Spit	95.8%	4.2%	0.0%
Chinook salmon ^b	Deception Creek	ND	ND	ND
	Ninilchik River	2.1%	97.7%	0.2%
	Crooked Creek	3.1%	96.9%	0.0%

^a Production goal target for coho salmon: 80% of smolt between 15.1 and 25.0 g

^b Production goal target for Chinook salmon: 80% of smolt between 5.1 and 15.0 g

Two release groups of coho salmon and 8 release groups of Chinook salmon were reared an additional 4 to 43 days in net pens or raceways at the release sites to facilitate imprinting and to achieve additional growth (Table 6).

Table 6.—Final release information for 8 release groups of Chinook salmon and 2 release groups of coho salmon that were held in net pens or raceways at the release sites for imprinting in 2009.

Species	Release area ^a	Release location	Transport date	Size at transport	Additional rearing days	Release date	Release size (g) ^b
Chinook salmon	CI	Ship Creek	14 May	5.9	22	3 Jun	7.6
	CI	Eklutna Tailrace	8 Jun	7.0	4	12 Jun	
	CI	Crooked Creek	1 Jun	8.1	19	20 Jun	11.0
	CI	Halibut Cove	18 Jun	9.6	13	1 Jul	
	CI	Homer Spit	17 Jun	9.4	6	23 Jun	
	CI	Homer Spit	24 Jun	10.3	6	30 Jun	
	CI	Seldovia	2 Jun	9.4	14	16 Jun	
	PWS	Fleming Spit	10 Jun	7.5	11	21 Jun	7.5
	PWS	Valdez, Old Town Site	15 Jun	7.5	43	28 Jul	18.2
Coho salmon	CI	Homer Spit	30 Jun	12.5	5	5 Jul	
	CI	Ship Creek	9 Jun	12.1	21	30 Jun	17.0

Note: Some release groups received additional rearing at the release site to facilitate growth.

^a CI is Cook Inlet; PWS is Prince William Sound.

^b Not all release groups held for imprinting were sampled for weight after additional rearing period.

DISCUSSION

SMOLT MARKING

A point of emphasis for the coded wire tag (CWT) marking program has been to achieve good long-term tag retention rates. Average long-term tag retention for Chinook salmon smolt in 2009 was 99.2%. Acceptable long-term tag retention (greater than 97%) has been achieved by grading fish and using different sizes of head molds. Deception Creek Chinook salmon smolt were not sampled for long-term tag retention nor examined for adipose fin clip quality before release because hatchery staff transported and released the smolt prior to their scheduled sampling and transport dates. The same crew marked and tagged the fish in all 3 of the tagged release groups. Therefore, acceptable long-term tag retention for the Deception Creek release group is likely.

Managers use adipose fin clips on hatchery-released fish to manage sport fisheries that target adult Chinook salmon returning to the Ninilchik and Kasilof rivers. Properly clipped fins are essential so that anglers and enforcement officials can distinguish between hatchery and nonhatchery fish.

Thompson and Blankenship (1997) found no fin regeneration in returning adult coho salmon when adipose fins were entirely removed at 12 months of age. When only the posterior two-thirds or the top two-thirds of the fin was removed, complete fin regeneration occurred in 23% of the fish. Partial fin regeneration occurred in 35% of the fish when the posterior two-thirds was removed, and in 63% of the fish when the top two-thirds was removed. Returning adults with partially regenerated adipose fins might not be identified as hatchery fish.

In our marked groups, 80% of the adipose fin, determined by visual estimation, was removed from 100% of the smolt, making fin regeneration unlikely. Identifying hatchery-released fish by the adipose fin clip in the adult return should be reliable.

Thermal Marking

Voucher samples indicate that coho salmon smolt released into Cook Inlet and Resurrection Bay and Chinook salmon smolt released into Cook Inlet contain TM variants. The cause of these variants is unknown, and these otoliths could be mistaken for otoliths from other releases.

SMOLT ENUMERATION

Peltz and Hansen (1994) reported that numerous sources of error associated with water displacement values make the water volume (WV) displacement method of estimating populations unreliable. They recommended this method be used only when other estimation methods cannot be used or when accuracy is not important.

The hatchery inventory (HI) and WV estimates differed by more than 10% (the WV technique estimated fewer fish than the HI technique in all cases) for 7 rearing units of Chinook salmon and 1 rearing unit of coho salmon in which tagging inventory (TI) counts were not available.

Hatchery staff reviewed HI estimate data (weight of fish loaded into the transfer box and mean weight of a fish) of each raceway for weighing and sampling errors, but no errors in methods were detected. The fish transfer data was misplaced, so the data could not be reviewed for this report. The fish transfer from indoor to outdoor raceways and the establishment of the HI for each raceway was conducted by the same hatchery personnel, so fish transfer procedures were consistent between raceways.

Fish predation by birds is a possible explanation for the discrepancy between the HI and WV estimation techniques. Waterfowl overwinter on the hatchery's settling pond and black-billed magpie birds (*Pica hudsonia*) perch on the tail screens to prey on fish.

To reduce fish predation by birds, netting suspended above the Chinook salmon raceways was draped down to cover the sides and both ends of the raceway compound. Hatchery staff accessed the raceways through an opening in the netting located between raceways D2 and D3 (Figure 4). The release groups in these 2 raceways were the most susceptible to predation by waterfowl and other birds because of their proximity to the walk-through opening in the netting. The discrepancy between the HI estimate (Homer Spit, Halibut Cove, and Seldovia releases) or TI count (Ninilchik River release) and the WV estimate for each of these 4 releases is greater than 54.3%. For 3 releases (Homer Spit, Halibut Cove, and Seldovia), it was obvious to hatchery staff that the WV estimates better represented the number of fish in these groups because the tanks on the stocking truck were underutilized on the transport trips. WV estimates were reported for these releases. Hatchery staff attribute the lower-than-expected WV estimate at release for the Ninilchik River release to the placement of the stocking truck on uneven ground during the fish loading process, resulting in an inaccurate displacement reading. The TI count was reported for this release.

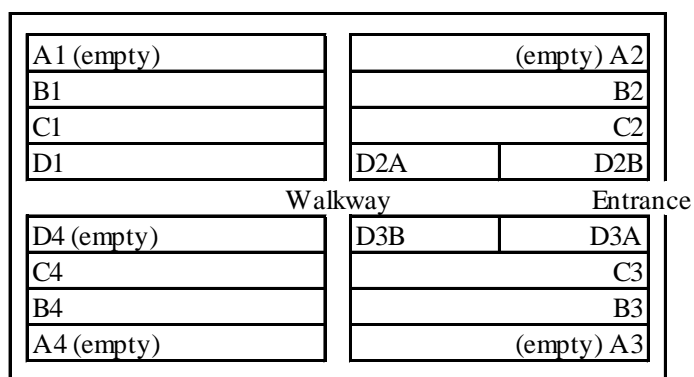


Figure 4.—Diagram of Chinook salmon rearing units at Fort Richardson Hatchery depicting location of rearing units in relationship to the main entrance to the area and center walkway.

Chinook salmon releases (Ship Creek and Eklutna Tailrace) in the 4 B-Bank raceways were diagnosed with *Flavobacterium branchiophila*, the causative agent of Bacterial Gill Disease. The fish populations in these raceways experienced mortality rates ranging from 4.7% to 15.2% over the last 2 to 3 months of rearing at FRH. The discrepancy between the HI and WV estimates for these raceways ranged from 11.9% to 19.5%. Black-billed magpie birds consumed dead and moribund fish at the water surface in front of the tail screens. Fish consumed by magpies could not be included in the mortality counts. Stocking truck tanks were underutilized when transporting the Eklutna Tailrace release; therefore, it is likely that the WV estimate is more accurate than the HI estimate for this release. HI estimates were reported for the other 3 B-bank raceways of Chinook salmon and the 1 raceway of coho salmon with 10% or greater differences between their HI and WV estimates.

The WV and HI estimates were within 10% of each other for all 4 C-Bank raceways and the 1 D-Bank raceway furthest from the entrance to the raceways.

SIZE ESTIMATION

To maximize ocean survival and maintain the age composition of the population, Peltz and Starkey (1993) recommended that 80% of hatchery coho salmon smolt weigh between 15.1 and 25.0 g, and hatchery Chinook salmon weigh between 5.1 and 15.0 g at release. Salmon at Fort Richardson Hatchery are reared outdoors for 1 year. The average outdoor rearing water temperature during the summer (June–August) of 2008 was 0.8°C cooler than the average water temperature for those same months for the previous 3 years (Fort Richardson Hatchery historic water temperatures). The cooler water temperatures probably inhibited growth in coho and Chinook salmon release groups.

RECOMMENDATIONS

- 1) All fish should be graded and tagged using the appropriate head mold sizes.
- 2) Care should be taken in tag placement to increase or maintain acceptable long-term retention rates.
- 3) During thermal marking, temperature changes of 4–5°C should occur every 24 hours between rings, and every 72 hours between bands of rings.
- 4) Production goal size recommendations should be followed such that 80% of coho salmon weigh between 15.1 and 25.0 g and 80% of Chinook salmon weigh between 5.1 and 15.0 g at release.
- 5) Continue to record individual bucket weights when determining hatchery inventory estimates in case of electronic scale failure.

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REFERENCES CITED

- Blankenship, H. L. 1990. Effects of time and fish size on coded wire tag loss from Chinook and coho salmon. *American Fisheries Society Symposium* 7:237-243.
- Loopstra, D., and P. A. Hansen. 2005. Marking, enumeration, and size estimation for coho and Chinook salmon smolt releases into Upper Cook Inlet, Resurrection Bay and Prince William Sound, Alaska, 2001-2003. Alaska Department of Fish and Game, Fishery Data Series No. 05-22, Anchorage. <http://www.adfg.alaska.gov/FedAidPDFs/Fds05-22.pdf>
- Loopstra, D., and P. A. Hansen. 2007. Coho and Chinook salmon smolt releases into Cook Inlet, Prince William Sound, and Resurrection Bay, Alaska, 2004. Alaska Department of Fish and Game, Fishery Data Series No. 07-75, Anchorage. <http://www.adfg.alaska.gov/FedAidPDFs/fds07-75.pdf>
- Loopstra, D., and P. A. Hansen. 2008. Coho and Chinook salmon smolt releases into Cook Inlet, Prince William Sound, and Resurrection Bay, Alaska, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 08-45, Anchorage. <http://www.adfg.alaska.gov/FedAidpdfs/fds08-45.pdf>
- Loopstra, D., C. Olito, and P. Hansen. 2000. Marking, enumeration, and size estimation for coho and Chinook salmon smolt releases into Upper Cook Inlet, Alaska in 1999. Alaska Department of Fish and Game, Fishery Data Series No. 00-8, Anchorage. <http://www.adfg.alaska.gov/FedAidPDFs/fds00-08.pdf>
- Loopstra, D. P., and P. A. Hansen. 2010. Coho and Chinook salmon smolt releases into Cook Inlet, Prince William Sound, and Resurrection Bay, Alaska, 2007. Alaska Department of Fish and Game, Fishery Data Series No. 10-04, Anchorage. <http://www.adfg.alaska.gov/FedAidpdfs/FDS10-04.pdf>
- Moberly, S. A., R. Miller, K. Crandall, and S. Bates. 1977. Marking tag manual for salmon. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement and Development, Juneau.
- Monk, K. M. *Unpublished*. Thermal marking manual: A guideline to the induction of thermal marks in otoliths for the purpose of mass-marking hatchery stocks. Located at Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Mark, Tag, and Age Laboratory, 10107 Bentwood Place, Juneau, Alaska, 99802-5526.
- Peltz, L., and P. A. Hansen. 1994. Marking, enumeration, and size estimation for coho and Chinook salmon smolt releases into upper Cook Inlet, Alaska in 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-21, Anchorage. <http://www.adfg.alaska.gov/FedAidPDFs/fds94-21.pdf>
- Peltz, L., and D. Starkey. 1993. Summary and synthesis of production, marking, and release data for coho and Chinook salmon smolt releases into upper Cook Inlet, Alaska in 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-51, Anchorage. <http://www.adfg.alaska.gov/FedAidPDFs/fds93-51.pdf>
- Sweet, D. E., and L. R. Peltz. 1994. Performance of the Chinook salmon enhancement program in Willow Creek, Alaska, 1985-1993. Alaska Department of Fish and Game, Fishery Manuscript No. 94-3, Anchorage. <http://www.adfg.alaska.gov/FedAidPDFs/fms94-03.pdf>
- Thompson, D. A., and H. L. Blankenship. 1997. Regeneration of adipose fins given complete and incomplete clips. *North American Journal of Fisheries Management* 17: 467-469.

APPENDIX A: HISTORICAL RELEASES OF CHINOOK AND COHO SALMON SMOLTS

Appendix A1.—Historical releases of coho salmon smolt with numbers of thermally marked, adipose fin clipped, and coded-wire-tagged fish.

					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT code	Estimate	Type ^a	Clipped	Tagged	Percent tagged	Mark group ^b	Hatch code
Anchorage Urban Streams ^c											
1994	Little Susitna	Ft Richardson	1996	31-25-06	302,857	M-R	93,975	92,565	30.56%		
Bird Creek											
1990	Little Susitna	Ft Richardson	1992	31-20-02, 03	95,377	M-R	44,903	37,629	39.50%		
1991	Little Susitna	Ft Richardson	1993	31-21-39	140,382	M-R	43,441	42,350	30.20%		
1992	Little Susitna	Ft Richardson	1994	31-23-02	84,643	M-R	45,220	44,686	52.80%		
1993	Little Susitna	Ft Richardson	1995	31-23-37	154,753	M-R	45,666	45,490	29.40%		
1994	Little Susitna	Ft Richardson	1996	31-25-04	147,618	M-R	46,528	45,411	30.80%		
1995	Little Susitna	Ft Richardson	1997	31-26-01	146,612	HI	45,901	45,488	31.03%		
1995	Little Susitna	Ft Richardson	1997	31-26-27	147,953	HI	45,836	45,469	30.73%		
1996	Little Susitna	Ft Richardson	1998	31-26-25	164,211	HI	46,140	46,094	28.07%		
1997	Ship Cr (Little Susitna)	Ft Richardson	1999	31-26-15	111,430	EC	37,344	36,746	32.98%		
1998	Ship Cr (Little Susitna)	Ft Richardson	2000	31-01-43	97,409	EC	40,114	39,392	40.44%		
2002	Ship Cr (Little Susitna)	Ft Richardson	2004		109,949	HI				CI	5H
2003	Ship Cr (Little Susitna)	Ft Richardson	2005 ^d		100,605	HI					
2004	Ship Cr (Little Susitna)	Ft Richardson	2006		104,974	HI				CI	5H
2005	Ship Cr (Little Susitna)	Ft Richardson	2007		104,979	HI				CI	1,5H
2006	Ship Cr (Little Susitna)	Ft Richardson	2008		113,035	HI				CI	1,5H
2007	Ship Cr (Little Susitna)	Ft Richardson	2009		113,300	HI				CI	1,5H ^e
Campbell Creek ^c											
1990	Little Susitna	Ft Richardson	1992	31-20-04, 05	97,076	M-R	43,681	39,444	40.60%		
1991	Little Susitna	Ft Richardson	1993	31-21-38	140,797	M-R	43,440	42,916	30.50%		
1992	Little Susitna	Ft Richardson	1994	31-23-03	87,686	M-R	44,144	42,963	49.00%		
1993	Little Susitna	Ft Richardson	1995	31-23-36	157,241	M-R	45,655	44,995	28.60%		
1995	Little Susitna	Ft Richardson	1997	31-25-62	71,519	TI	45,840	45,290	63.33%		
1996	Little Susitna	Ft Richardson	1998	31-26-52	83,317	HI	22,453	22,296	26.76%		
1997	Ship Cr (Little Susitna)	Ft Richardson	1999	31-01-30	42,046	EC	20,879	20,378	48.47%		

-continued-

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					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT code	Estimate	Type ^a	Clipped	Tagged	Percent tagged	Mark group ^b	Hatch code
Campbell Creek ^c (continued)											
1998	Ship Cr (Little Susitna)	Ft Richardson	2000	31-02-30	63,730	EC	19,948	19,549	30.67%		
1999	Ship Cr (Little Susitna)	Ft Richardson	2001	31-02-32	69,836	HI	21,568	20,813	29.80%		
2000	Ship Cr (Little Susitna)	Ft Richardson	2002	31-01-97	61,323	HI	22,789	21,672	35.34%	CI	5H
2001	Ship Cr (Little Susitna)	Ft Richardson	2003		78,576	HI				CI	5H
2002	Ship Cr (Little Susitna)	Ft Richardson	2004		85,790	HI				CI	5H
2003	Ship Cr (Little Susitna)	Ft Richardson	2005 ^d		60,387	HI					
2004	Ship Cr (Little Susitna)	Ft Richardson	2006		78,405	HI				CI	5H
2005	Ship Cr (Little Susitna)	Ft Richardson	2007		82,794	HI				CI	1,5H
2006	Ship Cr (Little Susitna)	Ft Richardson	2008		83,421	HI				CI	1,5H
2007	Ship Cr (Little Susitna)	Ft Richardson	2009		15,400	VOL				CI	1,5H ^e
Cottonwood Creek											
1990	Fish Creek	Big Lake	1992	31-20-08 31-21-09	53,900	M-R	35,341	32,938	61.10%		
1991	Fish Creek	Big Lake	1993	31-21-41	74,198	M-R	43,117	40,875	55.10%		
Eklutna Tailrace											
1996	Jim Creek	Ft Richardson	1998	31-26-27, 54, 55, 56	112,219	TI	112,219	111,882	99.70%		
1997	Jim Creek	Ft Richardson	1999	31-26-16	126,602	EC	44,073	42,663	33.70%		
1998	Jim Creek	Ft Richardson	2000	31-01-46	76,851	EC	40,514	40,149	52.24%		
1999	Eklutna Tailrace	Ft Richardson	2001	31-02-47	124,838	HI	43,713	43,494	34.84%		
2000	Eklutna Tailrace	Ft Richardson	2002	31-02-46	120,629	HI	44,518	44,295	36.72%	CI	5H
2001	Eklutna Tailrace	Ft Richardson	2003		120,736	HI				CI	5H
2002	Eklutna Tailrace	Ft Richardson	2004		131,979	HI				CI	5H
2003	Eklutna Tailrace	Ft Richardson	2005 ^d		132,149	HI					
2004	Eklutna Tailrace	Ft Richardson	2006		132,212	HI				CI	5H
2005	Eklutna Tailrace	Ft Richardson	2007		118,054	HI				CI	1,5H
2006	Eklutna Tailrace	Ft Richardson	2008		118,139	HI				CI	1,5H
2007	Jim Creek	Ft Richardson	2009		120,200	HI				CI	1,5H ^e

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					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT code	Estimate	Type ^a	Clipped	Tagged	Percent tagged	Mark group ^b	Hatch code
Fish Creek											
1990	Fish Creek	Big Lake	1992	31-20-12,13	74,953	M-R	45,538	43,625	58.20%		
1991	Fish Creek	Big Lake	1993	31-21-40	67,934	M-R	44,050	43,257	63.70%		
Homer Spit											
1996	Bear Lake	Elmendorf	1998	31-26-28	130,219	M-R	42,057	41,926	32.20%		
1997	Bear Lake	Elmendorf	1999	31-01-40	129,602	M-R	44,405	43,020	33.19%		
	Bear Lake	Elm/Ft. Rich	2000–01 ^d								
1999	Ship Cr (Little Susitna)	Ft Richardson	2001	31-01-36	100,280	HI	44,992	44,812	44.69%		
2000	Ship Cr (Little Susitna)	Ft Richardson	2002	31-01-98	95,648	HI	45,498	44,179	46.19%	CI	5H
2000	Bear Lake	Ft Richardson	2002		120,707	HI				CI	5H
2001	Ship Cr (Little Susitna)	Ft Richardson	2003		222,935	HI				CI	5H
2002	Ship Cr (Little Susitna)	Ft Richardson	2004		130,243	HI				CI	5H
2003	Ship Cr (Little Susitna)	Ft Richardson	2005 ^d		125,707	HI					
2004	Ship Cr (Little Susitna)	Ft Richardson	2006		125,216	HI				CI	5H
2005	Ship Cr (Little Susitna)	Ft Richardson	2007		127,711	HI				CI	1,5H
2006	Ship Cr (Little Susitna)	Ft Richardson	2008		122,843	HI				CI	1,5H
2007	Ship Cr (Little Susitna)	Ft Richardson	2009		113,696	HI				CI	1,5H ^e
Little Susitna at Houston											
1990	Little Susitna	Ft Richardson	1992	31-20-07	154,466	M-R	21,884	19,564	12.70%		
1991	Little Susitna	Ft Richardson	1993	31-21-37	148,282	M-R	21,404	20,312	13.70%		
Lowell Creek											
2000	Bear Lake	Ft Richardson	2002		119,512	HI				RB	4H
2001	Bear Lake	Ft Richardson	2003		124,389	HI				RB	4H
2002	Bear Lake	Ft Richardson	2004		131,989	HI				RB	4H
2003	Bear Lake	Ft Richardson	2005 ^d		132,276	HI					
2004	Bear Lake	Ft Richardson	2006		131,261	HI				RB	4H
2005	Bear Lake	Ft Richardson	2007		130,682	HI				RB	2,4H
2007	Bear Lake	Ft Richardson	2009		91,833	HI				RB	2,4H

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Appendix A1.–Page 4 of 5.

					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT code	Estimate	Type ^a	Clipped	Tagged	Percent tagged	Mark group ^b	Hatch code
Nancy Lake											
1990	Little Susitna	Ft Richardson	1992	31-20-06	158,459	M-R	21,598	19,222	12.10%		
1991	Little Susitna	Ft Richardson	1993	31-21-37	131,591	M-R	21,001	19,930	15.20%		
1992	Little Susitna	Ft Richardson	1994	31-23-01	126,694	M-R	44,489	43,818	34.60%		
1993	Little Susitna	Ft Richardson	1995	31-23-39	151,985	M-R	46,261	45,245	29.80%		
Seward Lagoon											
2000	Bear Lake	Ft Richardson	2002		121,743	HI				RB	4H
2001	Bear Lake	Ft Richardson	2003		123,718	HI				RB	4H
2002	Bear Lake	Ft Richardson	2004		131,798	HI				RB	4H
2003	Bear Lake	Ft Richardson	2005 ^d		132,229	HI					
2004	Bear Lake	Ft Richardson	2006		131,326	HI				RB	4H
2005	Bear Lake	Ft Richardson	2007		132,811	HI				RB	2,4H
2006	Bear Lake	Ft Richardson	2008		233,365	HI				RB	2,4H
2007	Bear Lake	Ft Richardson	2009		91,979	HI				RB	2,4H ^e
Ship Creek ^c											
1990	Ship Creek	Elmendorf	1992	31-19-63 31-20-01	67,178	TI	44,086	38,443	57.20%		
1991	Ship Creek	Elmendorf	1993	31-21-36	54,764	PC	42,112	41,322	75.50%		
1992	Ship Creek	Elmendorf	1994	31-23-04	75,779	PC	44,031	41,722	55.10%		
1993	Little Susitna	Ft Richardson	1995	31-23-38	158,981	M-R	45,491	44,654	28.10%		
1995	Little Susitna	Ft Richardson	1997	31-25-63	232,066	TI,HI	45,925	45,741	19.71%		
1996	Little Susitna	Ft Richardson	1998	31-26-53, 26	232,765	HI	67,812	66,997	28.78%		
1997	Ship Cr (Little Susitna)	Ft Richardson	1999	31-26-14 31-01-29	165,388	EC	48,299	45,380	27.44%		
1998	Ship Cr (Little Susitna)	Ft Richardson	2000	31-01-32 31-01-33	260,070	EC	61,640	58,989	22.68%		
1999	Ship Cr (Little Susitna)	Ft Richardson	2001	31-02-61	233,563	HI	64,165	61,663	26.40%		
2000	Ship Cr (Little Susitna)	Ft Richardson	2002	31-02-83	212,639	HI	67,959	63,678	29.95%	CI	5H

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					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT code	Estimate	Type ^a	Clipped	Tagged	Percent tagged	Mark group ^b	Hatch code
Ship Creek ^c (continued)											
2001	Ship Cr (Little Susitna)	Ft Richardson	2003	31-02-74, 69	234,716	HI	64,234	64,125	27.32%	CI	5H
2002	Ship Cr (Little Susitna)	Ft Richardson	2004	31-02-81 31-03-15	241,066	HI	63,222	62,906	26.09%	CI	5H
2003	Ship Cr (Little Susitna)	Ft Richardson	2005 ^d		251,446	HI					
2004	Ship Cr (Little Susitna)	Ft Richardson	2006		252,775	HI				CI	5H
2005	Ship Cr (Little Susitna)	Ft Richardson	2007		255,400	HI				CI	1,5H
2006	Ship Cr (Little Susitna)	Ft Richardson	2008		245,490	HI				CI	1,5H
2007	Ship Cr (Little Susitna)	Ft Richardson	2009		287,825	HI				CI	1,5H ^e
Wasilla Creek											
1990	Fish Cr	Big Lake	1992	31-20-10 31-20-11	76,315	M-R	44,148	41,985	55.00%		
1991	Fish Cr	Big Lake	1992	31-21-42	77,174	M-R	43,001	41,711	54.10%		
1994	Little Susitna	Ft Richardson	1996	31-25-05	145,923	M-R	46,980	46,839	32.10%		

^a Type of estimate: M-R is mark–recapture; TI is tagging inventory; HI is hatchery inventory; EC is electronic count; PC is physical count.

^b CI is Cook Inlet; RB is Resurrection Bay.

^c Campbell and Ship creeks were combined and termed “Anchorage Urban Streams” in 1996.

^d Stocking continued, but releases did not contain tagged or thermally marked fish.

^e See Table 3 for altered mark details.

Appendix A2.—Historical releases of Chinook salmon smolt with numbers of thermally marked, adipose fin clipped, and coded-wire-tagged fish.

					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Buskin River											
1994	Deception Creek	Elmendorf	1995	31-24-31	84,349	M-R	41,572	41,078	48.70%		
1995	Deception Creek	Elmendorf	1996	31-25-09	113220	M-R	41259	40681	35.90%		
Crooked Creek											
1993	Crooked Creek	Elmendorf	1994	31-23-14	224,784	M-R	43,609	43,034	19.10%		
1994	Homer (Crooked Cr)	Elmendorf	1995	31-24-27	184,049	M-R	40,903	38,420	20.90%		
1995	Homer (Crooked Cr)	Elmendorf	1996	31-25-12	193,180	M-R	40,827	40,196	20.80%		
1996	Homer (Crooked Cr)	Elmendorf	1997	31-25-55	223,200	M-R	41,049	39,038	17.49%		
1997	Homer (Crooked Cr)	Elmendorf	1998	31-26-29	137,338	M-R	42,874	42,610	31.03%		
1998	Homer (Crooked Cr) ^d	Elmendorf	1999	31-01-41	192,304	M-R	43,431	42,649	22.17%		
1999	Crooked Creek	Elmendorf	2000	31-02-31	108,507	TI	108,507	105,578	97.30%		
				31-01-34, 35							
2000	Crooked Creek	Elmendorf	2001	31-01-95	109,201	TI	109,201	107,454	98.40%		
				31-02-36, 37							
2001	Crooked Creek	Elmendorf	2002	31-02-51	99,547	TI	99,547	98,452	98.90%	CC	2,4H4 ^e
				31-01-96, 99							
2002	Crooked Creek	Ft Richardson	2003	31-02-72, 73, 68	98,800	TI	98,800	94,058	95.20%	CI	2,3H
2002	Crooked Creek	Ft.Richardson	2004	31-02-79, 80	80,601	TI	80,601	75,120	93.20%	CI	2,3H
2003	Crooked Cr	Ft.Richardson	2005	31-03-39, 40, 17	113,613	TI	113,071	113,499	99.90%	CI	2,3H ^f
2004	Crooked Cr ^g	Ft.Richardson	2006	31-03-56, 57, 51	111,705	TI	111,705	111,705	100.0%	CI	2,3H
2005	Crooked Cr ^h	Ft.Richardson	2007	31-03-68, 52	111,382	TI	111,382	111,271	99.9%	CI	2,3H
2006	Crooked Cr	Ft Richardson	2008	31-03-69, 70	114,588	TI	114,588	113,213	98.8%	CI	2,3H
2007	Crooked Cr	Ft Richardson	2009	31-03-75, 74, 14	115,035	TI	114,734	114,115	99.2%	CI	2,3H ⁱ
Deception Creek											
1991	Deception Cr	Ft Richardson	1992	31-21-03	179,724	M-R	44,089	33,464	18.60%		
1992	Deception Cr	Ft Richardson	1993	31-21-60	160,194	M-R	42,782	39,420	24.60%		

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					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Deception Creek (continued)											
1993	Deception Cr	Ft Richardson	1994	31-23-17	177,913	M-R	46,289	45,921	25.80%		
1994	Deception Cr	Ft Richardson	1995	31-24-34	184,740	M-R	46,807	46,256	25.00%		
1995	Deception Cr	Ft Richardson	1996	31-25-14	186,918	M-R	47,700	47,145	25.20%		
1996	Deception Cr	Ft Richardson	1997	31-26-03, 04, 05, 06, 07	209,644	TI	209,644	207,973	99.20%		
1997	Deception Cr	Ft Richardson	1998	31-25-32	197,392	TI	197,392	195,615	99.10%		
1998	Deception Cr	Ft Richardson	1999	31-26-17, 18, 19, 20	201,586	TI	201,586	199,722	99.08%		
				31-01-31							
1999	Deception Cr	Ft Richardson	2000	31-26-21	206,496	TI	206,496	205,051	99.30%		
				31-01-44							
				31-02-33, 34, 35							
2000	Deception Cr	Ft Richardson	2001	31-02-41, 42, 43, 44, 45	207,465	TI	207,465	204,560	98.60%		
2001	Deception Cr	Ft Richardson	2002	31-01-92	197,277	TI	197,277	196,608	99.66%	DC	2,5H
				31-02-52, 53, 54, 55							
2002	Deception Cr	Ft Richardson	2003	31-02-70, 71	101,181	TI	101,181	99,562	98.40%	CI	2,3H
				31-01-94							
2002	Deception Cr	Ft Richardson	2004	31-02-77, 78	113,523	TI	113,523	104,101	91.70%	CI	2,3H ^j
				31-03-16							
2003	Deception Cr	Elmendorf	2004	31-02-75, 76	99,047	TI	99,047	97,660	98.60%	CI	2,3H
				31-01-27							
2003	Deception Cr	Ft Richardson	2005	31-03-28, 29, 30, 31	163,016	TI	161,991	162,415	99.63%	CI	2,3H ^f
2004	Deception Cr ^g	Ft Richardson	2006	31-03-53, 54, 55, 27	50,426	TI	50,426	50,376	99.90%	CI	2,3H
2005	Deception Cr	Ft Richardson	2007	31-03-67, 26	103,016	TI	103,016	103,016	100.00%	CI	2,3H
2006	Deception Cr	Ft Richardson	2008	31-03-71, 73	112,219	TI	112,219	111,321	99.20%	CI	2,3H
2007	Deception Cr ^g	Ft Richardson	2009	31-03-77, 50, 49	111,322	TI	111,099	111,322	100.00%	CI	2,3H ⁱ

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					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Eagle River											
1993	Ship Creek	Elmendorf	1994	31-23-13	98,872	M-R	43,612	41,669	42.10%		
Eklutna Tailrace											
2001	Ship Creek	Elmendorf	2002		106,991	VOL				ET	2,3H3
2002	Ship Creek	Ft Richardson	2003		218,492	HI				CI	2,3H
2002	Ship Creek	Ft Richardson	2004		215,165	HI				CI	2,3H ^j
2003	Ship Creek	Ft Richardson	2005		164,586	HI				CI	2,3H ^f
2004	Ship Creek	Ft Richardson	2006		213,250	HI				CI	2,3H
2005	Ship Creek	Ft Richardson	2007		110,978	HI				CI	2,3H
2006	Ship Creek	Ft Richardson	2008		114,136	HI				CI	2,3H
2007	Ship Creek	Ft Richardson	2009		77,785	VOL				CI	2,3H ⁱ
Fleming Spit											
1998	Deception Cr	Ft. Richardson	1999	31-26-23	49,773	TI	45,705	45,385	91.18%		
1999	Deception Cr	Elmendorf	2000	31-01-38	45,000	VIS	17,358	17,236	38.30%		
2000	Deception Cr	Elmendorf	2001	31-02-38	94,812	HI	40,659	40,415	42.63%		
2001	Deception Cr	Ft. Richardson	2002	31-02-57	109,656	HI	40,054	39,573	36.09%	PWS	2,4H
2002	Deception Cr	Ft. Richardson	2003		109,757	HI				PWS	2,4H
2003	Deception Cr	Ft. Richardson	2004		58,000	HI				PWS	2,4H
2003	Deception Cr	Ft. Richardson	2005		87,591	HI				PWS	2,4H ^f
2004	Ship Creek ^k	Ft. Richardson	2006		113,576	HI				CI	2,3H ^k
2005	Deception Cr	Ft. Richardson	2007		119,860	HI				PWS	2,4H
2006	Deception Cr	Ft. Richardson	2008		114,627	HI				PWS	2,4H
2007	Deception Cr	Ft Richardson	2009		68,173	HI				PWS	2,4H

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					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Halibut Cove											
1993	Crooked Creek	Elmendorf	1994	31-23-15	98,872	M-R	21,205	21,038	21.30%		
1994	Ninilchik River	Elmendorf	1995	31-24-30	37,577	M-R	36,944	36,700	97.70%		
1995	Ninilchik River	Elmendorf	1996	31-25-11	97,729	M-R	40,688	39345	40.30%		
1996	Ninilchik River	Elmendorf	1997	31-25-58	78,133	M-R	40,919	39487	50.54%		
1997	Ninilchik River	Elmendorf	1998	31-26-32	65,893	M-R	38,476	38041	57.73%		
	Ninilchik River	Elmendorf	1999–01 ¹								
2001	Ninilchik River	Elmendorf	2002		106,279	VOL				KB	2,4H3
2002	Ninilchik River	Ft Richardson	2003		106,844	HI				CI	2,3H
2002	Ninilchik River	Ft Richardson	2004		103,771	HI				CI	2,3H
2003	Ninilchik River	Ft Richardson	2005		112,521	HI				CI	2,3H ^f
2004	Ninilchik River	Ft Richardson	2006		117,549	HI				CI	2,3H
2005	Ninilchik River ^h	Ft Richardson	2007		54,560	HI				CI	2,3H
2006	Ninilchik River	Ft Richardson	2008		58,674	HI				CI	2,3H
2007	Ninilchik River	Ft Richardson	2009		35,065	WV				CI	2,3H ⁱ
Homer Spit (early run)											
1993	Crooked Creek	Elmendorf	1994	31-23-16	163,963	M-R	26,003	25,615	15.60%		
1994	Homer (Crooked Cr)	Elmendorf	1995	31-24-32	216,026	M-R	41,650	40,291	18.70%		
1995	Homer (Crooked Cr)	Elmendorf	1996	31-25-07	204,085	M-R	40,868	39,017	19.10%		
1996	Homer (Crooked Cr)	Elmendorf	1997	31-25-60	217,773	M-R	41,112	38,810	17.82%		
1997	Homer (Crooked Cr)	Elmendorf	1998	31-26-33	177,730	M-R	40,012	39,652	22.31%		
1998	Homer (Crooked Cr)	Elmendorf	1999	31-01-45	163,170	M-R	42,561	40,423	24.77%		
	Ninilchik River	Elmendorf	2000–01 ¹								
2001	Ninilchik River	Elmendorf	2002		190,026	VOL				KB	2,5H3
2002	Ninilchik River	Ft Richardson	2003		206,292	HI				CI	2,3H
2002	Ninilchik River	Ft Richardson	2004		143,037	HI				CI	2,3H
2003	Ninilchik River	Elmendorf	2004		25,706	VOL				CI	2,3H
2003	Ninilchik River	Ft Richardson	2005		220,822	HI				CI	2,3H ^f
2004	Ninilchik River	Ft Richardson	2006		224,053	HI				CI	2,3H

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Appendix A2.–Page 5 of 8.

					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Homer Spit (early run, continued)											
2005	Ninilchik River	Ft Richardson	2007		226,972	HI				CI	2,3H
2006	Ninilchik River	Ft Richardson	2008		212,141	HI				CI	2,3H
2007	Ninilchik River	Ft Richardson	2009		164,234	HI				CI	2,3H ⁱ
Homer Spit (late run)											
1992	Kasilof River	Crooked Creek	1994	31-23-19	56,920	M-R	22,612	22,383	39.30%		
1994	Homer (Kasilof R)	Elmendorf	1995	31-24-33	123,048	M-R	41,054	40,466	32.90%		
1995	Homer (Kasilof R)	Elmendorf	1996	31-25-13	108,204	M-R	40,615	38,787	35.80%		
1996	Homer (Kasilof R)	Elmendorf	1997	31-25-61	100,933	M-R	41,028	39,264	38.90%		
1997	Homer (Kasilof R)	Elmendorf	1998	31-26-34	112,100	HI	40,158	39,997	35.68%		
	Homer (Kasilof R)	Elmendorf	1999 ¹								
Lowell Creek											
1996	Deception Cr	Elmendorf	1997	31-25-59	102,147	M-R	40,906	40,497	39.65%		
	Deception Cr	Elmendorf	1998–99 ¹								
	Crooked Creek	Elmendorf	2000–01 ¹								
2001	Crooked Creek	Elmendorf	2002		93,296	VOL				RB	2,5H3
2002	Crooked Creek	Ft Richardson	2003		110,331	HI				RB	2,5H
2002	Crooked Creek	Ft Richardson	2004		89,388	HI				RB	2,5H
2003	Crooked Creek	Ft Richardson	2005		100,088	HI				RB	2,5H ^f
Ninilchik River											
1991	Ninilchik River	Ft Richardson	1992	31-21-04	132,387	M-R	43,648	41,335	31.20%		
1992	Ninilchik River	Ft Richardson	1993	31-21-59	184,585	M-R	44,487	42,960	23.30%		
1993	Ninilchik River	Ft Richardson	1994	31-23-18	201,513	M-R	46,193	45,535	22.60%		
1994	Ninilchik River	Ft Richardson	1995	31-24-35	54,902	TI	54,902	54,353	99.00%		
1995	Ninilchik River	Ft Richardson	1996	31-25-15	51,688	TI	51,588	50,866	98.60%		

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Appendix A2.–Page 6 of 8.

Brood year	Brood stock	Hatchery	Release year	CWT Code	Total released		Released with coded wire tag			Thermal marking	
					Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Ninilchik River (continued)											
1996	Ninilchik River	Ft Richardson	1997	31-26-08	50,698	TI	50,698	50,292	99.20%		
1997	Ninilchik River	Ft Richardson	1998	31-26-35	48,798	TI	48,798	47,480	97.30%		
1998	Ninilchik River	Ft Richardson	1999	31-01-47	49,853	TI	49,853	48,906	98.10%		
1999	Ninilchik River	Ft Richardson	2000	31-02-48	51,298	TI	51,298	50,016	97.50%		
2000	Ninilchik River	Ft Richardson	2001	31-02-60	54,770	TI	54,770	54,441	99.40%		
2001	Ninilchik River	Ft Richardson	2002	31-02-82	54,631	TI	54,631	54,139	99.10%	NR	2,3H
2002	Ninilchik River	Ft Richardson	2003	31-02-56	47,997	TI	47,997	44,349	92.40%	CI	2,3H
				31-01-83							
2002	Ninilchik River	Ft Richardson	2004	31-03-18	51,303	TI	51,303	51,252	99.90%	CI	2,3H
2003	Ninilchik River	Ft Richardson	2005	31-03-41	55,229	TI	54,806	54,898	99.40%	CI	2,3H ^f
2004	Ninilchik River ^g	Ft Richardson	2006	31-03-58	57,537	TI	57,537	57,537	100.00%	CI	2,3H
2005	Ninilchik River	Ft Richardson	2007	31-03-66	56,325	TI	56,037	55,869	99.19%	CI	2,3H
2006	Ninilchik River	Ft Richardson	2008	31-03-72	56,943	TI	56,868	56,658	99.50%	CI	2,3H
2007	Ninilchik River	Ft Richardson	2009	31-03-76	54,797	TI	54,797	54,304	99.10%	CI	2,3H ⁱ
Seldovia											
1993	Crooked Creek	Elmendorf	1994	31-23-11	107,246	M-R	46,754	45,439	42.40%		
1994	Homer (Crooked Cr)	Elmendorf	1995	31-24-29	116,165	M-R	41,609	40,678	35.00%		
1995	Ninilchik River	Elmendorf	1996	31-25-10	118,274	M-R	40,667	39,610	33.50%		
1996	Ninilchik River	Elmendorf	1997	31-25-57	103,757	M-R	41,279	39,834	38.39%		
1997	Ninilchik River	Elmendorf	1998	31-26-31	69,461	M-R	40,654	40,125	57.77%		
	Ninilchik River	Elmendorf	1999–01 ¹								
2001	Ninilchik River	Elmendorf	2002		83,045	VOL				KB	2,4H3
2002	Ninilchik River	Ft Richardson	2003		107,521	HI				CI	2,3H
2003	Ninilchik River	Elmendorf	2004		88,682	VOL				CI	2,3H
2003	Ninilchik River	Ft Richardson	2005		114,984	HI				CI	2,3H ^f
2004	Ninilchik River	Ft Richardson	2006		113,974	HI				CI	2,3H
2005	Ninilchik River	Ft Richardson	2006		54,276	HI				CI	2,3H
2006	Ninilchik Rver	Ft Richardson	2008		54,464	HI				CI	2,3H
2007	Ninilchik Rver	Ft Richardson	2009		44,487	VOL				CI	2,3H ⁱ

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Brood year	Brood stock	Hatchery	Release year	CWT Code	Total released		Released with coded wire tag			Thermal marking	
					Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Seward Lagoon											
2001	Crooked Creek	Elmendorf	2002		100,314	VOL				RB	2,5H3
2002	Crooked Creek	Ft. Richardson	2003		109,976	HI				RB	2,5H
2003	Crooked Creek	Elmendorf	2004		109,600	VOL				RB	2,5H
2003	Crooked Creek	Ft. Richardson	2005		114,847	HI				RB	2,5H ^f
2004	Deception/Crooked Crs	Ft. Richardson	2006		116,826	HI				RB	2,5H
2004	Ship Creek ^k	Ft. Richardson	2006		109,795	HI				CI	2,3H ^k
Ship Creek											
1993	Ship Creek	Elmendorf	1994	31-23-12	199,830	M-R	44,138	42,864	21.50%		
1994	Ship Creek	Elmendorf	1995	31-24-28	218,487	M-R	40,764	38,570	17.70%		
1995	Ship Creek	Elmendorf	1996	31-25-08	231,444	M-R	41,221	40,109	17.30%		
1996	Ship Creek	Elmendorf	1997	31-25-56	326,371	M-R	40,522	40,319	12.36%		
1997	Ship Creek	Elmendorf	1998	31-26-30	204,741	M-R	42,073	41,565	20.30%		
1998	Ship Creek	Elmendorf	1999	31-01-42	197,168	M-R	44,265	42,262	21.44%		
	Ship Creek	Elmendorf	2000–01 ^l								
2001	Ship Creek	Elmendorf	2002		290,501	VOL				SC	2,4H4
2002	Ship Creek	Ft Richardson	2003		329,416	HI				CI	2,3H
2002	Ship Creek	Ft Richardson	2004		209,060	HI				CI	2,3H ^j
2003	Ship Creek	Elmendorf	2004		111,166	HI				CI	2,3H
2003	Ship Creek	Ft Richardson	2005		344,191	HI				CI	2,3H ^f
2004	Ship Creek	Elmendorf	2005		13,838	VOL					
2004	Ship Creek	Ft Richardson	2006		60,412	HI				CI	2,3H
2004	Ship Creek ^k	Ft Richardson	2006		115,643	HI				PWS	2,4H ^k
2005	Ship Creek	Ft Richardson	2007		333,940	HI				CI	2,3H
2006	Ship Creek	Ft Richardson	2008		341,495	HI				CI	2,3H
2007	Ship Creek	Ft Richardson	2009		282,735	HI				CI	2,3H ⁱ

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					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Valdez Area											
1998	Deception Cr	Ft Richardson	1999	31-26-22	49,353	TI	46,528	45,923	93.05%		
1999	Deception Cr	Elmendorf	2000	31-01-37	115,582	M-R	41,728	41,060	35.52%		
2000	Deception Cr	Elmendorf	2001	31-02-39	94,701	HI	44,418	43,974	46.43%		
2001	Deception Cr	Ft Richardson	2002	31-02-58	107,861	HI	43,833	42,650	39.54%	PWS	2,4H
2002	Deception Cr	Ft Richardson	2003		109,661	HI				PWS	2,4H
2002	Deception Cr	Ft Richardson	2004		99,464	HI				PWS	2,4H ^j
2003	Deception Cr	Ft Richardson	2005		143,209	HI				PWS	2,4H ^f
2004	Ship Creek	Ft Richardson	2006		112,221	HI				PWS	2,4H
2005	Deception Cr	Ft Richardson	2007		126,241	HI				PWS	2,4H
2006	Deception Cr	Ft Richardson	2008		126,703	HI				PWS	2,4H
2007	Deception Cr	Ft Richardson	2009		107,883	HI				PWS	2,4H
Whittier Area											
1998	Deception Cr	Ft Richardson	1999	31-26-24	49,797	TI	45,023	43,897	88.21%		
1999	Deception Cr	Elmendorf	2000	31-01-39	119,389	M-R	43,551	42,898	35.93%		
2000	Deception Cr	Elmendorf	2001	31-02-40	95,823	HI	42,800	42,458	44.31%		
2001	Deception Cr	Ft Richardson	2002	31-02-59	109,763	HI	45,854	44,799	40.81%	PWS	2,4H
2002	Deception Cr	Ft Richardson	2003		109,700	HI				PWS	2,4H
2002	Deception Cr	Ft Richardson	2004		107,705	HI				PWS	2,4H ^j
2003	Deception Cr	Elmendorf	2004		20,906	VOL				PWS	2,4H
2003	Deception Cr	Ft Richardson	2005		118,059	HI				PWS	2,4H ^f

^a Type of estimate: M-R is mark–recapture; TI is tagging inventory; HI is hatchery inventory; VIS is a visual estimate; VOL is volumetric estimate.

^b Beginning in 2005, number of clipped fish released is adjusted to reflect percent of acceptable fin clips observed at release.

^c CC is Crooked Creek; CI is Cook Inlet; DC is Deception Creek; ET is Eklutna Tailrace; KB is Kachemak Bay; NR is Ninilchik River; PWS is Prince William Sound; RB is Resurrection Bay; SC is Ship Creek.

^d Corrections for release numbers reported in Loopstra et al. (2000).

^e See Loopstra and Hansen (2005) for altered mark details.

^f See Loopstra and Hansen (2008) for altered mark details.

^g Not sampled for long-term coded wire tag retention or fin clip quality at release. Coded wire tag data are based on overnight tag retention and acceptable finclip rates.

^h Corrections for release numbers reported in Loopstra and Hansen (2010).

ⁱ See Table 3 for altered mark details.

^j See Loopstra and Hansen (2007) for altered mark details.

^k Due to bacterial kidney disease (BKD) infection, release groups were switched at release in order to stock healthier fish at brood source release sites.

^l Stocking continued, but releases did not contain tagged or thermally marked fish.

APPENDIX B: DISPLACEMENT VALUES FOR FISH TRANSPORT TANKS

Appendix B1.–Displacement values (kg/mm) for fish transport tanks.

Vehicle	Displacement kg/mm
SV33804	2.70
SV36544	2.60
SV36905	1.42
SV33697	2.20
SV33259	3.21

Source: John Unterberg, ADF&G, Fort Richardson Fish Hatchery, December 2010.